

TANAPA Environmental Management Plan Guidelines for Road Improvements



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Foreword

As stewards of Tanzania's National Parks, we know that the impacts associated with our roads and trails tend to be far-reaching and extensive. These *TANAPA Environmental Management Plan Guidelines for Road Improvements* are an important addition to our efforts to systematically develop and manage our park resources. Their application, together with the companion *TANAPA Procedures for Environmental Reviews of Road Improvements* and the *USAID/TANAPA Programmatic Environmental Assessment for Road Improvements in Tanzania National Parks*, should help to ensure all future TANAPA road and trail undertakings occur in an environmentally sound manner. Doing so will serve to further protect our special heritage, while at the same time contributing to the continuing development of Tanzania's tourism sector, with important economic benefits to the National Park System, local communities, and our Nation's economy.

These *Guidelines* are for use by each park's Environmental Management Team under the overall direction of the Environmental Review Coordinator and the Warden in Charge. They guide preparation of the annual *Environmental Management Workplan* for road improvements which must be part of the annual budget submission process. Our full commitment is necessary for successful implementation of road improvement programs in the parks.

Comments on their appropriateness and ease of use should be submitted to my office.



Lota Melamari
Director General
Tanzania National Parks

Organization of the Guidelines

These *Environmental Management Plan Guidelines* for road improvements:

- help the Environmental Management Teams in each park apply principles of environmentally sound design and management to all road improvements in our parks so as to ensure their long-term sustainability and visitor appeal;
- provide a systematic approach to the implementation of mitigation and monitoring measures identified in *Environmental Reviews* conducted for proposed road segment improvements; and
- explain the requirements for the preparation and submission of the annual *Environmental Management Workplan* for road improvements, which is to accompany park budget submission justifications.

The *Guidelines* are divided into five sections:

Section 1 provides instructions for completion of the *Environmental Management Workplan* for road improvements;

Section 2 contains road improvement environmental mitigation tips and illustrations;

Section 3 provides a detailed compendium of key mitigation measures organized by activity phase: *planning & design, construction, operation & maintenance, and decommissioning (abandonment)*;

Section 4 explains how to complete the mitigation and monitoring forms which are to be submitted with the park *Environmental Management Workplan*;

Section 5 consists of blank template environmental mitigation and monitoring forms, to be completed by the park Environmental Management Team under the overall direction of the Environmental Review Coordinator for each park.

Section 1

Instructions for completion of the *Environmental Management Workplan* for road improvements

The *Annual Environmental Management Workplan* for road improvements is to be completed by the park Environmental Management Team under the overall direction of the Park Environmental Review (ER) Coordinator. Both the Team and the ER Coordinator are appointed by the Warden in Charge. In most instances, the Warden in Charge may select the Park Ecologist to serve as the ER Coordinator. Other members of the Environmental Management Team should consist at a minimum of the key person within the park responsible for road and trail improvements and maintenance, the Park Tourism Warden, and the Park Community Conservation Warden. Other members may be added on an as-needed basis.

Use the following format to complete the *Workplan* and provide:

1. A list of road segment improvements planned for the coming year. Include in the list:
 - location and length;
 - road classification and nature of improvement;
 - materials, equipment and labor requirements;
 - estimated budgets;
 - time schedule;
 - appropriate maps (topographic, sketch, etc.) showing proposed road improvement segments.
2. A summary of the mitigation measures that will be undertaken during planning and design, construction, operation, and decommissioning/abandonment. Provide timetables and estimated costs for implementation. This summary should be drawn from the completed mitigation forms found in *Section 5* of the *Environmental Management Plan Guidelines*.
3. A summary of *Workplan* elements that require followup monitoring (supervision) to ensure mitigation measures are working; the monitoring indicators to be used; the adequacy of baseline information and data; a description of how often monitoring will take place (frequency), and estimated costs. When appropriate, include recommendations for monitoring sensitive locations and exceptional resources, or particular environmental features or components, particularly when impacts may occur and where no mitigative measures are feasible (in other words, there are residual impacts that cannot be mitigated).
4. A review of special issues and future needs. Special requests including budget and personnel estimates for environmental assessments; focused environmental analyses; ecological studies; protection strategies for exceptional resources; road/trail network surveys; modification or elaboration of Management Zone Plans or General Management Plans, etc. to improve environmentally sound design and management.
5. Completed mitigation and monitoring forms from *Section 5* of these *Guidelines*.
6. A copy of the previous annual *Workplan*, together with a commentary on results and targets achieved and those still pending under the new *Workplan*.

Section 2

Road improvement environmental mitigation tips and illustrations

Table 1 : Standardized Road Classification System for Tanzania National Parks

ROAD USE	CLASS	DESCRIPTION	AVERAGE TRAVELED WIDTH
Major Access	Class I	Cambered, ditches, turnouts, murram surfacing, full 2-lane traffic, all-weather 2WD; roads are shaped and cambered, have drainage ditches and turnouts for removing water from roadway, and have been surfaced full length with murram	7 m
Minor Access	Class II	Cambered, ditches, turnouts, murram surfacing, 1-lane with room for slow speed passing, all-weather 2WD; roads are shaped and cambered, have drainage ditches and turnouts for removing water from roadway, and have been surfaced full length with murram	4.5 m
Minor Access	Class III	Cambered, ditches, turnouts, 1-lane with room for slow speed passing, all-weather 4WD; roads are shaped and cambered, have some drainage ditches and turnouts, and have limited amount of murram at soft spots	4.5 m
Game Viewing	Class IV	Cambered, ditches, turnouts, 1-lane, may not be accessible at all times, 4WD; roads are shaped and cambered, have some drainage ditches and turnouts, and have limited amount of murram at soft spots	3 m
Game Viewing	Class V	No camber or shaping but could be lightly graded, 1-lane, not accessible during wet season, 4WD, basically 2-track	3 m
Administrative	Class V	No camber or shaping but could be lightly graded, 1-lane, not accessible during wet season, 4WD, not open to visitors; basically 2-track	3 m

Table 2

AINA YA BARABARA	DARAJA	MAELEZO	WASTANI WA UPANA WA BARABARA
BARABARA KUU	Daraja La I	Daraja hii ya barabara huchongwa na kuwekewa mgongo; miteneji ya pembeni; mitaro ya pembeni ili kwondoa maji kwenye uso wa barabara; huwa na upana wa kuwezesha magari mawili kupishana kwa mwendo mkali/wastani (yaani huwa na njia mbili ie 2-lane traffic) hupitika majira yote ya mwaka; hutu-miwa na magari yan ayoendeshwa kwa kutumia matairi mawili (yaani 2WD). Urefu wote wa barabara aina hii huwekwa moram.	mita 7
BARABARA NDOGO	Daraja La II	Daraja hii ya barabara huchongwa na kuwekewa mgongo; mifereji ya pembeni mitaro ya pembeni ili kmondoo maj kwenye uso wa barabara; huwa na upana mdogo wa kuwezesha magari kupishana kati ka mwendo mdogo (yaani 1-lane traffic). Hupitika majira yote ya mwaka; hutumi wa na magari yanayoen deshwa kwa kutumia matain mawili (yaani 2WD). Daraja hii ya barabara huwekwa moram urefu wote.	mita 4.5
BARABARA NDOGO	Daraja La III	Daraja hii ya barabara huchongwa na kuwekewa mgongo; mifereji ya pembeni; mitaro ya pembeni ili kuondoa maji katika uso wa barabara; huwa no upana mdogo wa kuwezesha magari kupishana katika mwendo mdogo (yaani 1-lane traffic). Hutumiwa na magari yanayoendeshwa kwa kutumia matain manne (yaani 4WD). Doraja hii ya barabara huwekwa moranu katr-ka baadhi ya Sehemu zilizo korofi na kupitika majira yote ya mwake.	mita 4.5
BARABARA YA UTALII	Daraja La IV	Daraja hii ya barabara huchongwa na kuwekewa mgongo; mifenej ya pembeni; mitaro ya pembeni; huwa na upana mdogo wa kawezesha magan mawili kupishana kati ka mwendo mdogo (yaani 1-Lane traffic); huenda isipitike katika majiva Fulani ya mwaka. Hutumiwa na magan yanagoe ndeshwa kwa kutamia matain manne (yaani 4WD) Moram huwekwa kath ka baadlin ya Sehemu zibizokorofi	mita 3.
BARABARA YA UTALII	Daraja La V	Daraja hii ya barabara haina mgongo bali huchwngwa kwa machine bandlin ya sehenu; huwezesha magain mawi li kau pishana kwa mwendo mdogo (yaani 1-lane traffic); haipitiki wakati wa mvua nyingi; hutumiwa na magari yanayoendeshwa kwa kutumia matein manne (yaani 4WD)	mita 3.
BARABARA ZAUTAWALA	Daraja La V	Daraja hii ya barabara heine magongo bali huchongwa boadlin ya schemu ziu zo mbaya; hutumiwa na magari yanayoendeshwa kwa kutumia matairi manne (yaane 4 WD). Haipitiki wakati wa mvua nyingi. Daraja hii ya barabar <u>HAIRUHIUSIWI</u> kutumiwa na wageni bali hutumiwa kuh shughuli za UTAWALA tu.	mita 3.

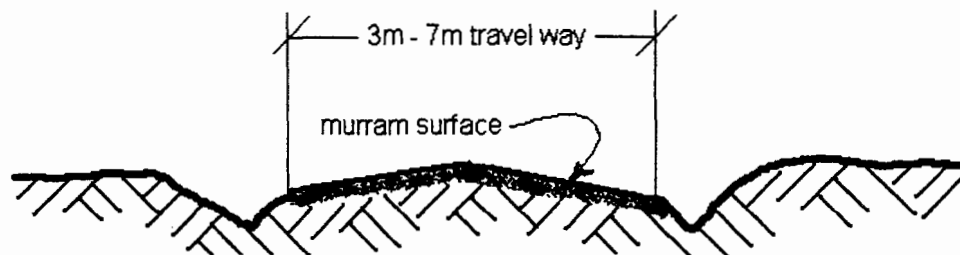
Figure 1
Typical Existing Road Section



Wear and grading or erosion has lowered road surface below surrounding landscape; road now collects rain runoff and is wetter than surroundings

Mmomonyoko umesababisha uso wa barabara kuwa chini zaidi ya kingo zake za pembeni; sasa barabara inakusanya maji ya mvua na kusababisha barabara kulowana sana kuliko maeneo mengine ya pembeni mwa barabara

Typical Proposed Road Cross Section

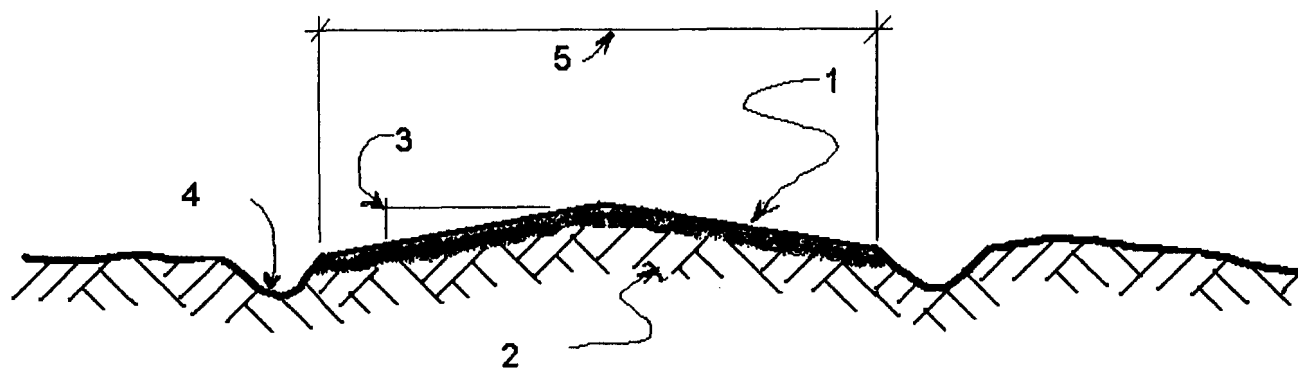


Side Drain Ditch - depth of ditch will vary along the length of the run between turnout or outlet

Mtaro wa Maji Wa Pembeni mwa Barabara - kina cha mtaro wa maji wa pembeni mwa barabara hutofautinana kulingana na umbali kati ya mtaro wa kutoa maji nje ya barabara

Note: Max Camber Slope:
1 in 40 to 1 in 33
(2.5%) (3%)

Figure 2
Cross Section of a Gravel Road



KEY

- 1 - Layer of murram; thickness of murram layer depends on soil type at site
- 2 - Subgrade
- 3 - Cross-slope 1 in 33 to 1 in 40
(3%) (2.5%)
- 4 - Side drain ditches
- 5 - Traveled way, width depends on the class of road

UFUNGUO

- 1 - Moramu; unene wa kina cha moramu hutegemea aina ya udongo mahali pale
- 2 - Udongo uliashindiliwa chini ya moramu
- 3 - Ulalo wa mgongo wa barabara
(1 kwa 33 hadi 1 kwa 40)
(3%) (2.5%)
- 4 - Mitaro ya pembeni
- 5 - Upana wa barabara; vipimo vya upana wa barabara hutegemea daraja la barabara

Figure 3

Drainage in Hilly Roads Cross Section
Mitaro Ya Maji Katika Maeneo Ya Milimani

Key

- 1 - Water catchment ditches/drains
- 2 - Side ditch drain
- 3 - Traveled way

Ufunguo

- 1 - Mitaro ya maji katika milima
- 2 - Mitaro ya maji pembeni mwa barabara
- 3 - Upana wa barabara

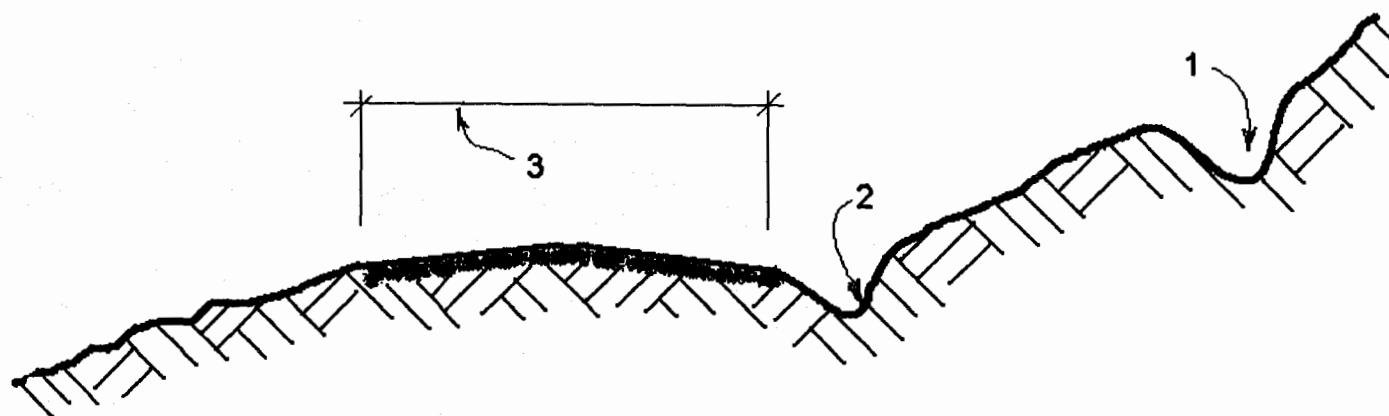
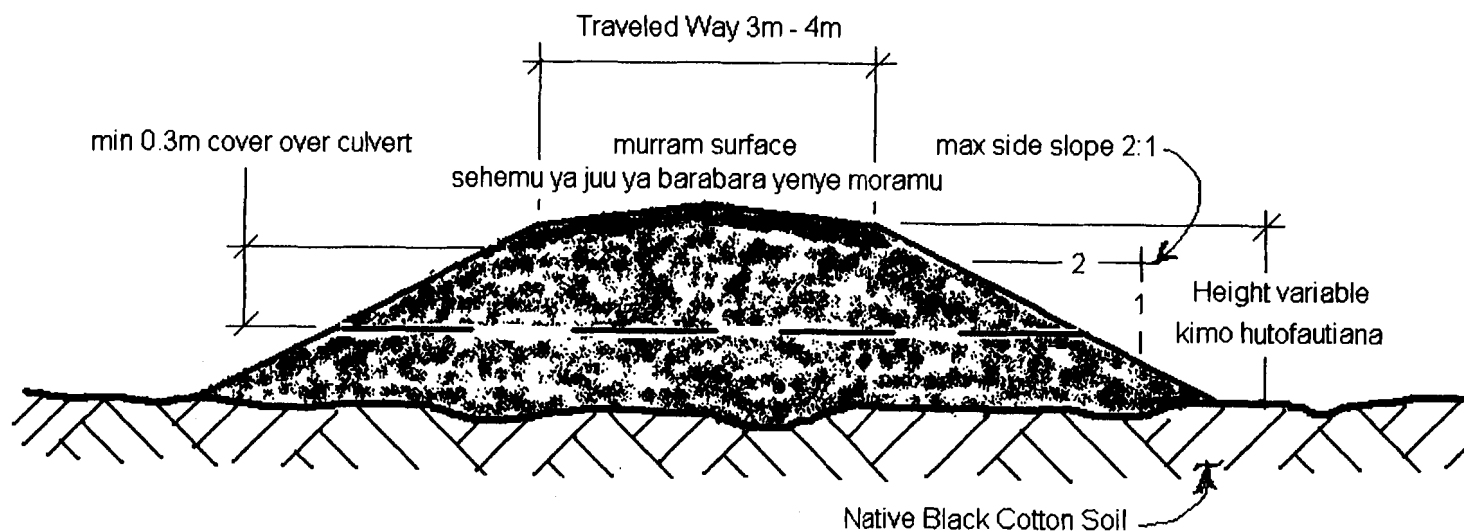


Figure 4
Raised Road Embankment

Typical proposed Black Cotton fill cross section
Barabara/tuta ihyonyanyuliwa katika sehemu yenye udongo mweusi

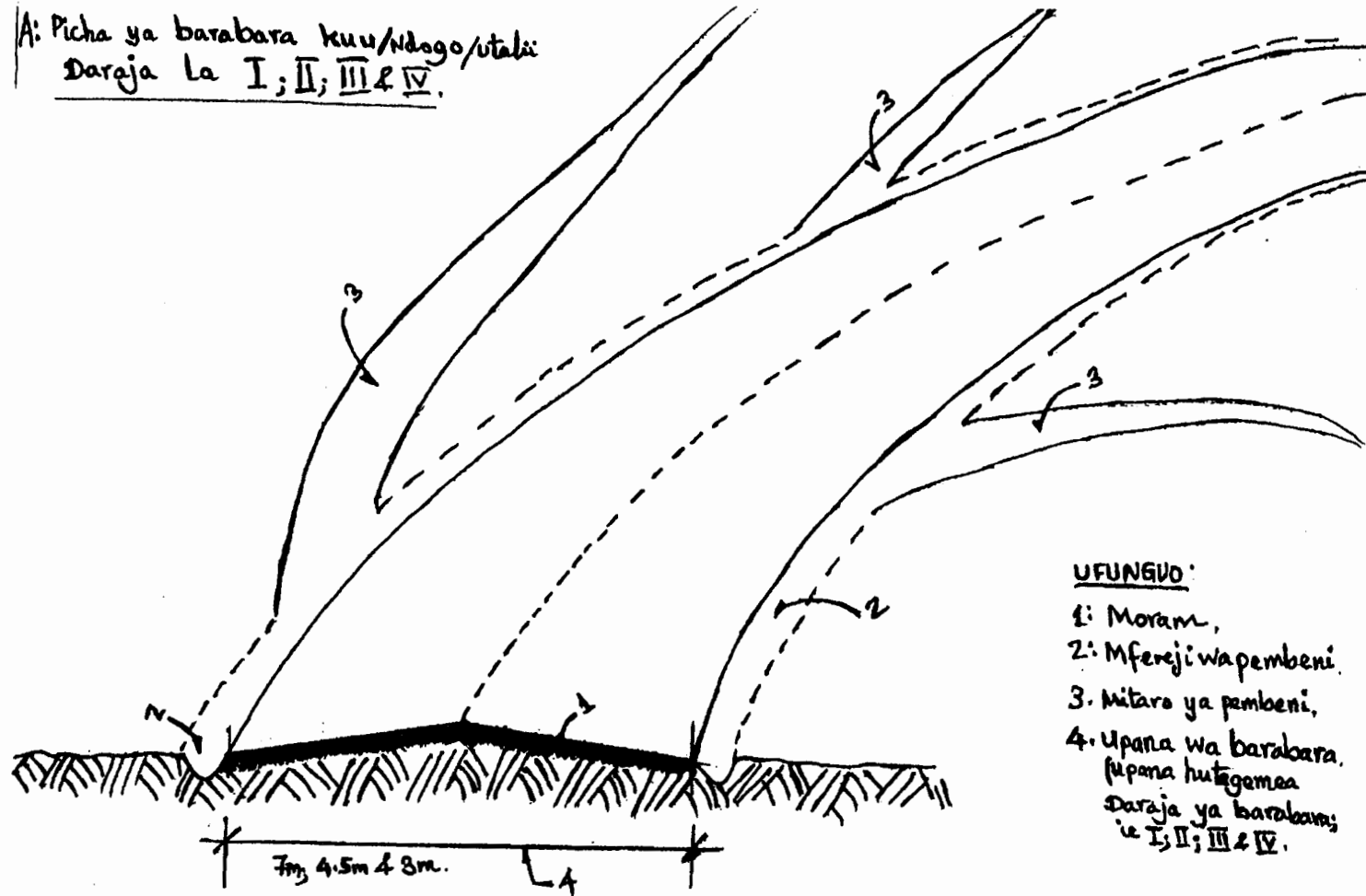


Note: Reapply surface vegetation and surface soil to new fill slopes to aid in revegetation

Rudishia majani na udonogo wa juu wenye rutuba katika pande az tuta ili kusaidia majani kuota tena

Figure 7

A: Picha ya barabara kuu/ndogo/utali:
Daraja La I; II; III & IV.



UFUNGUO:

- 1: Moram,
- 2: Mfereji wapembeni.
- 3: Mitaro ya pembeni,
- 4: Upana wa barabara, fupana hutegemea daraja ya barabara; i.e I; II; III & IV.

Section 3

Key mitigation/enhancement measures organized by activity phase: planning & design, construction, operation & maintenance, and decommissioning (abandonment)

Table 3. Summary of Impact Mitigation/Enhancement Measures

Number	Impacts	Mitigation/Enhancement Measure
	Significant physical impacts and mitigation	
1	Soil erosion and surface runoff	
1.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • Make the TANAPA Road Works motto “Ondoa Maji Barabarani” --- “Keep the Water Off the Road.” • Develop and provide TANAPA design standards for runout drains, drifts and culverts, cambering, and application of murram. • Develop standards for following contours, avoiding gradients greater than 10%, or long straight downhill stretches. • Revise policies related to off-road driving to further restrict this practice in the national parks. (Impacts and mitigation measures associated with off-road driving are discussed below under <i>Operation and Maintenance</i>.) • Use a multidisciplinary team (ecologist, road engineer, soil scientist, hydrologist, tourism specialist) in selecting new routes. • Follow contours where feasible, and consider routings at the base of hills, where coarse alluvium tends to collect, instead of crossing valleys and floodplains often characterized by fine clay deposits (black cotton or vertisols), that are impassable during wet weather. • Where slopes are overly steep and eroding, consider moving the road. Make decisions on realignments for steep slopes by studying severity of erosion, soil type and relationship to existing erosion control methods. Erosion control for gradients greater than 10% may be difficult on many park roads. Where realignment is the preferred alternative, use a multidisciplinary team to select route and design, and follow contours, where feasible. • Select grader drivers carefully, based on their ability to follow correct design and maintenance standards to keep water off the roads.

Number	Impacts	Mitigation/Enhancement Measure
		<ul style="list-style-type: none"> • Identify areas that collect or gully water by driving the roads after moderate rains. Mark locations and develop road maintenance and rehabilitation to deal specifically with these problem spots. • Design roads with wheel tracks elevated above side channel water. See alternative designs shown in Figures 1 through 5, e.g., two ditches with cambered center, or road with a little pitch and single side ditch. Provide side channels/runouts to prevent gulying and standing pools. • Avoid placement of roads too close to river and stream banks and construction of roads on unstable soils. Conduct land surveys and soil studies needed prior to construction/realignment. • Weigh costs of construction and future maintenance of improvement against benefits and, if costs appear to exceed benefits, consider no action or decommissioning existing segment.
1.2	<i>Construction</i>	<ul style="list-style-type: none"> • Control flow and distribution of water on and around park roads. • Minimize the amount of clearing. • Limit earth moving to dry periods. • Protect susceptible soil surfaces with vegetative matter. • Clear and grub erodible soil in limited areas at any one time. • Store topsoil for respreading. • Install temporary or permanent erosion control features. • Revegetate as soon as possible. • If vegetation must be removed, do so during the dry season. • If removed during wet periods, do not disturb ground until just before road construction is to start. • Protect drainage channels with berms, straw or fabric barriers. • De-commission original road sections which are no longer necessary following realignment. (See 1.4 below.) • For steep slopes, install drainage turnouts at more frequent intervals; install drainage check dams to stop ditch erosion; use cuts or fills at either end of

Number	Impacts	Mitigation/Enhancement Measure
		steep sections to reduce road or quarry site grades or inclines; use higher grade of murram that erodes much less; provide soil stabilizers or tarmac at very steep sections of roads.
1.3	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • To ensure maintenance of rehabilitated roads over the long-term and reduce erosion potential, close roads (use of rain barriers) during periods when the surface is wet and soft, where appropriate. • For improperly graded roads, use grader to respread berm materials at road center, camber and reshape driving surface, compact surface, and establish adequate ditches along road edge, so that vehicles wheels travel above water in side ditches. • Maintain drainage structures and ditches to prevent gulying and standing pools. Clean side channels/runouts when they begin to fill with sediment and lose their effectiveness. • For wind-caused soil erosion on light soils, improve roads with designated murram tracks. • Rotate road closures (temporary closure of roads to allow recovery); provide additional game viewing tracks to lower visitor vehicle traffic levels on any one road. • Where readily available use murram selectively to reduce wind and tire erosion, dust and rutting. • On heavily utilized roads consider use of chemical soil stabilizers. • Water the road immediately prior to compaction to strengthen the road surface. (Otherwise, traffic will soon beat back the road surface to pre-bladed condition) • Mitigate against soil erosion on trails with stone step work and runout drains, where appropriate. • Allow work crews to work flexible hours to take advantage of natural night moisture. Have crews ready to work at daybreak, when the ground still has a trace of the night's moisture.

Number	Impacts	Mitigation/Enhancement Measure
		<ul style="list-style-type: none"> • Rest crews at mid-day to reduce maintenance dust effects. • Schedule road maintenance for immediately after rainy seasons to take advantage of natural moisture for compaction of Class I and II roads. • If feasible, use pneumatic rubber tire rollers pulled behind grader to compact Class III and Class IV roads, where needed.
1.4	<i>Decommissioning</i>	<ul style="list-style-type: none"> • Depending on the seriousness of erosion and levels of compaction, decommission by ripping, shaping and re-vegetating abandoned road segments to stabilize soil and minimize erosion, subsequent surface run-off, and siltation. • Divert all water away from eroded and gullied roads/tracks and trails. • Use barriers, "CLOSED" signs, pamphlets and other awareness techniques to keep visitors and operators off abandoned roads/tracks and trails. Provide stiff operator penalties for off-road driving violations. • Where erosion or gullying is not significant, use of barriers to prevent vehicle traffic may be sufficient to allow revegetation. • Survey roads near sensitive areas annually to determine where closures are needed, and when regenerated areas might be re-opened.
2	Siltation and debris deposition	
2.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • Work with District Councils, villages and NGOs to develop regional assessments of land use outside the parks, and to develop both regional environmental assessments and regional plans for reducing population pressures. • Foster awareness and strengthen relationships with communities outside the parks (but which are in park watersheds), so as to help them develop and apply soil conservation technologies and practices in upper catchment areas. Encourage support from District Councils, NGOs and others for this purpose.

Number	Impacts	Mitigation/Enhancement Measure
		<ul style="list-style-type: none"> • Consider the potential impact of 100-year floods in design of bridges versus drifts, including silt, debris deposition and cost implications of each. Construct drifts rather than bridges, where feasible and cost-effective. • If bridges are needed, consider using bridges that can be easily erected and dismantled, such as Bailey Bridges. (Then if waterways meander, the structure can be dismantled and moved to another site.)
2.2	<i>Construction</i>	<ul style="list-style-type: none"> • Minimize siltation through erosion control. Refer to the discussion for soil erosion for impacts and mitigations of roadway erosion in PEA Section 6.3.1 <i>Soil erosion and surface runoff</i>.
2.3	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Use water-catchment trenches placed above the road to intercept and divert water and sediments away from the road and into stream channels, or use berms above the road in the same manner. • Accumulated material in the trenches should be regularly cleaned out prior to each rainy season, or as needed. • Experiment with training rivers and streams by unblocking stream channels of debris and silt, so as to encourage streams to follow desired channels. Use a combination of hand labor, small machinery, and selective bulldozer work where feasible (remembering that dozer tracks can easily expose soil to erosion and do more harm than good). Determine whether "training" watercourses is a cost-effective technique for controlling silt and debris disposal on road surfaces. • See mitigation measures discussed under <i>Wetlands</i> to minimize environmental impacts associated with possible breakdown of heavy equipment used to train streams, and associated pollution effects. • Use strategic placement of trenches upslope of roads to divert water away from the road and into stream channels, but keep trenches back from the road and hidden from park visitors. Use berms on the upper side of the

Number	Impacts	Mitigation/Enhancement Measure
		road to achieve similar water diversion.
3	Soil Compaction	
3.1	<i>Construction and operation</i>	<ul style="list-style-type: none"> • Fill mud holes and potholes with good quality murram; remove downed trees, and limbs obscuring roadways. • Educate tour operators and visitors to stay on the road. • Maintain or upgrade road so drivers are encouraged to use the existing road. • Upgrade track or road if surface conditions deteriorate due to heavy use.
4	Hydrology	
4.1	<i>Construction and operation</i>	<ul style="list-style-type: none"> • Install sufficient culverts across the roadway to pass water from the uphill side to the downhill side, keeping in mind potential flood conditions and debris deposition problems. • Modify the cut or fill design to lessen potential hydrological impacts. • Eliminate cutting and filling in especially sensitive areas such as wetlands. • Require regular culvert inspections to ensure proper operation. • Control waste materials and fuels/oil to prevent contamination of the surrounding land and water. • Use construction techniques to avoid potential flooding of borrow pits and spoil areas, where potential exists for spread of disease vectors. • Use water speed reduction measures, drainage structures, settling basins, or infiltration ditches to reduce adverse hydrological effects. • In flood-prone areas, incorporate retention basins in design, to reduce runoff peaks or to improve drainage in low-lying agricultural areas. • Consider appropriate diversion structures or retention ponds if a proposed road improvement has the potential to aggravate flooding as a consequence of drainage system modifications, channelize runoff or create additional impervious surfaces, depending on the magnitude of the impact.

Number	Impacts	Mitigation/Enhancement Measure
		<ul style="list-style-type: none"> • Where feasible, use water collected in settling basins and retention ponds for road maintenance to reduce potential disease vectors. • Reduce soil erosion and flooding through controlled flow through a well-designed drainage system, thereby reducing long-term sediment transport and enhancing the quality of surface water in streams.
5	Drainage	
5.1	<i>Construction and operation</i>	<ul style="list-style-type: none"> • Refer to mitigation measures above for <i>Soil erosion and surface runoff</i>. • Design and construct roads with sufficient shape and camber to keep the wheel track elevated above drainage ditches. • Provide runout drains at sufficient intervals to handle anticipated drainage. • Make runout drains sufficiently long to allow water to evenly dissipate and percolate into the ground. • Provide sufficient culverts, as necessary, to allow water to flow to the downhill side of the road. (Keep in mind that corrugated steel culverts tend to rust and eventually collapse in the Tanzanian environment and that culverts which are too narrow can quickly lose their utility if blocked by floodwater debris.)
6	Surface water quantity	
6.1	<i>Construction</i>	<ul style="list-style-type: none"> • Avoid or minimize surface water use during the dry season. • Prewet murram prior to the dry season when more water is available and store murram in a way that will keep it wet. • Delay compaction activities until the beginning of the wet season or when water becomes more available.

7	Surface water quality	
7.1	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Site material storage locations and work depots carefully, take precautions to avoid spills, collect and recycle lubricants, use grease traps, dikes, retention basin or sumps to mitigate impacts. • Store oil, fuels, and waste materials properly so that precipitation and runoff does not come into contact with these products and materials. • Provide oil/water separators at points of discharge of surface water from impervious surfaces that may contain waste oil, fuels, and other contaminants. • Maintain separators according to manufacturer's instructions. • In sensitive areas such as wetlands, take special precaution against potential adverse effects such as high turbidity, debris, grease and oil from construction equipment, sand and cement, and other construction related wastes.
8	Ground water quantity and quality	
8.1	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Ensure fuel tanks are not leaking by careful observation of fuel levels as compared to fuel delivered and fuel used (using care to protect workers exposed to fuel fumes during monitoring). • Ensure fuel pumps and piping are not leaking at any joints, or at pump penetrations. • Eliminate over-filling of fuel tanks during delivery or during vehicle fueling operations. • Collect all waste oil and remove from park, preferably to a central buyer. • Ensure waste oil does not spill onto the ground. • Use drop clothes or wood shavings to capture leaks and spills occurring during equipment maintenance. • Tighten fuel lines at generators and other stationary equipment. • Construct concrete pads with catch drains for vehicle and equipment repair and servicing.

	Significant ecological/biological impacts and mitigation	
9	Habitat change and species diversity	
9.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • Involve ecologists, tourism specialists and engineers in deciding where and how to utilize and/or avoid sensitive habitats. Use the GMP/MZP planning process to identify, protect and utilize sensitive habitats. • Conduct inventories of flora and fauna and ecological studies of species behavior prior to road or trail development in suspected sensitive habitat areas. • Consider limiting day visitors to certain sections of the Park only and charging higher fees for those who wish to travel beyond the day visitor zone. • Consider having day visitors park their vehicles at designated lots, then transfer them to larger vehicles to experience the day visitor zone. • Raise fees to keep demand at a level that does not exceed Management Zone Plan <i>Limits of Acceptable Use</i>. (See <i>Limits of acceptable use (LAU)/carrying capacity mitigation measures below</i>) • Keep roads and parking lot areas at sufficient distance to ensure adverse impacts do not occur. • Avoid siting of roads and trails in areas or locations that may affect animal behavior, as well as sensitive habitats such as the kopjes in Serengeti, the hot springs in Lake Manyara, and the bird breeding areas around Momella Lakes in Arusha National Park.
9.2	<i>Construction</i>	<ul style="list-style-type: none"> • Strictly enforce TANAPA water policy which highly restricts the use of all surface water in the parks. (Especially where sensitive habitats exist, such as hippo pools in the Serengeti, sensitive riverine vegetation and ground water forests, springs and water holes.)

9.3	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Clearly designate roads and identify trails that pass near sensitive habitats, and enforce visitor and tour operators' use of designated roads and trails only. • Allow off-road driving in approved zones only where strict limits of acceptable use (LAUs) are followed for those zones, where effective and frequent monitoring can be performed, and where drivers observe the "no driving over another vehicles tracks" rule. Discontinue legal off-road driving wherever scarring is observed. • Employ booking systems and/or increase fees for visits to sensitive areas or exceptional resources in order to restrict vehicle traffic close to or through these, and to keep vehicle numbers within acceptable LAUs. • Discourage illegal off-road driving by: maintaining and using designated roads only and strongly enforcing off-road driving policy; increasing tour operator and visitor awareness; increasing use of park guides; and heavily penalizing tour companies whose drivers violate park regulations concerning off-road driving (e.g., temporary bans on offending tour companies). • Engage tour operators in helping report off-road driving violations. • Many of these mitigation measures should also be applied to roads that are posted "CLOSED."
9.4	<i>Decommissioning</i>	See the discussion under <i>Section 6.2.1 of the PEA - Soil erosion and surface runoff.</i>

10	Wetlands	
10.1	<i>Construction</i>	<ul style="list-style-type: none"> • Avoid cut and fill across wetlands. • Use a multidisciplinary team (land surveyor, geotechnical engineer, ecologist, tourism specialist) to conduct cost-benefit analyses of alternatives to crossing wetland areas. • Where possible find an alternative around low-lying areas following the contour of hills. (Often lower hill slopes have an alluvial composition with significantly lower clay content than found in low-lying areas.) • Consider other transport alternatives for moving goods, park personnel and visitors, including: <ul style="list-style-type: none"> - park-owned (or contracted) light aircraft during rainy seasons when movement is impossible; - "swamp buggies" or airboats (see Section 2.2.2 of the PEA; - no action, i.e., continued use of existing tracks through wetlands during dry seasons only. • Before construction commences and work is undertaken, determine how spoil will be disposed of or shaped. • Carefully select storage sites and laydown areas to avoid risk of contamination of wetlands with fuel, lubricants, chemicals or other products used in the operation of equipment and construction activities, and to prevent drainage into wetlands. • Where wetlands impacts (blocking of cross-drainage or filling, for example) cannot be avoided, provide mitigative compensation by protecting other wetlands. (It is assumed that creation or enhancement of other wetlands as replacement would be cost-prohibitive.) • Pay particular attention to potential impacts on wetlands during bridge drift construction.
10.2	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Avoid transportation of petrol or hazardous chemicals across wetland areas. • Add protection of wetland resources to overall tour operator and visitor awareness campaigns.

11	Forest land and tropical forest	
11.1	<i>Construction</i>	<ul style="list-style-type: none"> • Apply TANAPA's formal environmental screening and review procedures governing loss of tropical forest and degradation of protected areas (see <i>TANAPA Procedures for Environmental Reviews of Road Improvements, 2001</i>), specifically for Tarangire and Lake Manyara National Parks. • Similarly, apply the <i>TANAPA Procedures for Environmental Reviews</i> related to threatened and endangered species. • Avoid acquisition of additional Right of Way (ROW) through tropical forests. Use a multidisciplinary team (land surveyor, geologist/soil scientist, ecologist, tourism specialist) to conduct cost-benefit analyses of alternative routes and alternative transportation methods to avoid new road construction or realignment of roads through forested areas and especially tropical forest. • If clearing is unavoidable, provide appropriate replacement vegetation to control erosion as mitigative compensation, and/or protect or restore forests elsewhere within the drainage basin as close as possible to those lost. • Use a multidisciplinary team to conduct cost-benefit analyses of alternate sites for minor borrow pits, debris disposal areas and construction camps in order to reduce unnecessary loss or degradation of forest and other vegetation. The inventory work should be integrated with an examination of the impacts on forest lands or other sensitive areas, such as wetlands, endangered or threatened species, unique habitat, or other exceptional features (e.g., cultural, historical, paleontological or archeological resources). Avoid siting these ancillary works near sensitive areas and exceptional features. • Develop and follow standards for restoration/decommissioning of murrum pits, construction camps, debris and waste disposal areas, including requirements and procedures for reclaiming the land for subsequent sustainable use. • Avoid detours through forest or wetlands whenever possible. • If detours are required to maintain traffic flow during rehabilitation, and no practical alternatives are available, restore land used for detours (e.g., forest or other vegetation) to prior condition. • Minimize or prohibit fuelwood harvesting by construction work forces.

		<p>Consider provision of alternative fuel sources to reduce demand on local fuelwood sources and/or use of vegetation unavoidably cleared during the construction process.</p> <ul style="list-style-type: none"> Minimize use of cut and fill through forested areas. See the wetlands discussion above regarding cut and fill and suggested mitigation measures.
11.2	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> Use murram where feasible and affordable to minimize effects of dust on sensitive habitats, species and other exceptional resources. Conduct informational campaigns to heighten awareness about fire, particularly during the dry season. Posting of caution/warning signs could lessen risk. If use of herbicides or pesticides are considered, put in place procedures and training for safe and effective use in order to protect human and wildlife populations and to avoid contamination of water bodies.
11.3	<i>Indirect and induced effects</i>	<ul style="list-style-type: none"> If TANAPA constructs new roads outside the parks, ensure adherence to <i>TANAPA Procedures for Environmental Reviews of Road Improvements</i>. Strengthen joint TANAPA, District and Local Government joint district level environmental assessment and environmental/natural resource planning.
12	Sensitive areas, threatened and endangered species and ecological functioning	
12.1	<i>Planning and design</i>	<ul style="list-style-type: none"> Use a multidisciplinary team (ecologist, archaeologist, road engineer, soil scientist, tourism specialist, etc.) to survey or inventory areas with sensitive species or ecological features (such as kopjes), in combination with inventories of exceptional paleontological, archeological, historical or cultural features (e.g., rock paintings or gong rocks). The survey should be followed by a prioritization process to: <ul style="list-style-type: none"> Identify exceptional features where no access will be allowed (in order to protect unique biodiversity or ecological characteristics);

		<ul style="list-style-type: none"> - identify features for special use (e.g., guided and self-guided walking trails with designated car park areas); - plan car park areas to match anticipated vehicle usage and provide proper drainage; - identify sensitive areas where driving is permitted (generally off-road, but assess each year to determine if areas should be closed for recovery or off-road policy modified) and apply murram where necessary; - determine minimum access distance to kopjes; and - undertake awareness training for tour operators, drivers and park visitors. <ul style="list-style-type: none"> • These suggestions could affect <i>Limits of Acceptable Use</i> (LAU). To mitigate potential impacts, consider limiting visitor numbers through introduction of higher fees for walking tours. Also, consider the application of booking systems with special permits to restrict visitor access to levels that will allow sustainable conservation of sensitive areas and exceptional resources values. • Use the GMP/MZP planning process to identify, protect and utilize sensitive habitats. • Ensure adherence to <i>TANAPA Procedures for Environmental Reviews</i> regarding loss of tropical forest, degradation of protected areas, and threatened and endangered species. • Re-route roads to avoid adverse effects on sensitive resources. • Close roads that are currently too close to sensitive resources and substitute walking trails with escorts, where feasible. • Commission hydrological and ecological studies for sensitive water bodies (e.g., Momella lakes in Arusha National Park) in order to understand their aging processes and stages of eutrophication and the potential impact of road/trail improvements near these water bodies. • Ensure no surface run-off to lakes through monitoring of existing runout drains. • Conduct inventories of flora and fauna and ecological studies of species behavior prior to road or trail development in suspected sensitive habitat areas.
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12.2	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • If endangered or threatened species are present and could be affected by road improvement activities (especially new road construction, or realignments of existing road segments), an Environmental Assessment would be called for, paralleling TANAPA and USAID environmental procedures. Environmental Assessment following TANAPA and USAID procedures would also be required for any potential adverse effects on protected areas or relatively undegraded forest. (See <i>TANAPA Procedures for Environmental Reviews of Road Improvements</i>.)
12.3	<i>Decommissioning</i>	<ul style="list-style-type: none"> • Close roads passing too close to sensitive areas to motorized traffic with permanent barriers and substitute with walking trails, where feasible.
12.4	<i>Indirect and induced effects</i>	<ul style="list-style-type: none"> • Support species inventories and ecological monitoring research to maintain sensitive habitats and to develop effective mitigation plans for sensitive areas, threatened and endangered species and ecological functioning.
13	Exceptional resources: ecological, paleontological, archaeological, historical and cultural	
13.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • See above under <i>Sensitive areas, threatened and endangered species and ecological functioning</i>. • Consult with appropriate officials and museum sources to determine if areas have the potential to contain buried resources (e.g., fossils, archeological remains, and cultural artifacts). If warranted, conduct field surveys where such potential exists. • Put in place procedures that require construction crews and supervisors to be alert to buried resources and which also provide them with guidance in the event they are uncovered. • Define responsibilities for road crews and companies (e.g., contract clauses, incentives for protection, penalties for damage).

13.2	<i>Construction</i>	<ul style="list-style-type: none"> • Ensure construction crews and supervisors follow established TANAPA procedures and/or contract clauses for handling possible buried resources. • Provide rewards and incentives for proper handling of buried resources, and penalties for loss or damage to these resources.
13.3	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Heighten awareness and enforcement of regulations on the part of park authorities responsible for the protection of cultural resources. • Limit visitor numbers through the use of booking systems and/or higher fees for visits to exceptional features. • Create barriers (natural materials, if feasible) around selected features to limit access only to approved routes. • Provide stiff penalties for any damage to exceptional resources.
14	Wildlife migration/movement and animal harassment	
14.1	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Increase enforcement of speeding regulations. • Employ additional speed control technology and methods (speed guns appear to be more effective than speed bumps because drivers memorize speed bump locations). • Design new roads and road realignments to meander, as curving roads deter overspeeding. • On existing straight roads, ensure brush clearing of Right of Way (ROW) is wide enough for vehicles traveling at high speed to see approaching wildlife and vice versa. • Strengthen informational campaigns to heighten visitor and tour operator awareness of the hazards to animals and vehicles of speeding, and the negative effects on visitor experience. • Post caution signs and lower speed limits in areas with abundant or unique fauna. • Engage tour operators in helping report speeding violations and animal accidents.

15	Alien Species	
15.1	<i>Construction, operation and maintenance</i>	<ul style="list-style-type: none"> • Avoid murram material that may contain exotic seed. • Conduct botanical and ecological inventories for exotics. • Instruct road crews to remove rapid colonizers and quick spreading or reproducing invader species by hand, while control is still manageable. • Enlist assistance from student groups, where road crew labor is not adequate to control undesirable invasive species. • In situations where potential for spread of exotic species is high, wash heavy equipment (park-owned or private contractor) before it enters the park.
	Landscape impacts	
16	Scenic quality and viewshed	
16.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • Conduct a parkwide inventory of the existing road networks in <i>each</i> of Tanzania's national parks, involving a multidisciplinary team (landscape architect/planner, ecologist, road engineer, geotechnical engineer, tourism planner). The study should identify which roads are, in fact, well-located, and which roads might eventually be realigned to enhance park aesthetics and to reduce adverse effects, such as soil erosion or threats to sensitive areas. Also, determine which roads might be replaced by trails, or permanently decommissioned. • Avoid siting roads that cut long, straight paths across valleys and plains, and are in plain view at higher elevations. • Where feasible, design roads to minimize adverse viewshed effects on park visitors by following hill contours, hiding roads beneath forest cover, and using meanders to improve scenic quality. Avoid siting roads along river courses that place vehicles on one side of the river in the viewshed of vehicles on the other side. • Apply a "clean slate" concept. In other words, consider realigning all minimal tracks to follow contours and avoid sensitive areas, recognizing that existing minimal tracks can be ripped (to accelerate regeneration of vegetation) and abandoned with no noticeable scars or impact on the environment.

		<ul style="list-style-type: none"> • Manage off-road driving to minimize habitat change, soil erosion, and degradation of scenic quality. (See <i>Habitat change and species diversity</i> mitigation measures above.) • Use a multidisciplinary team (land surveyor, geologist/soil scientist, ecologist, tourism specialist) to conduct a siting study of existing and potential future sites for quarries and murrum pits in and around all of the national parks, to determine their extent and quality, and to develop through cost-benefit analysis a TANAPA-wide quarry and murrum pit management plan. Include in the plan a prioritized list of sites for each park. • Site quarries and murrum pits so that they are not visible to visitors. • Take photos of sites before initiating excavation, so that restoration can match original site characteristics as much as possible. • Develop specific procedures for extraction of murrum, storage of topsoil, phased closure, and reshaping and restoration when extraction has been completed. • Locate construction camp sites so that they are not visible from the tourist roads or tracks. • Provide appropriate training for the road inspector and grader operators on ways to deal with spoil materials.
16.2	Construction	<ul style="list-style-type: none"> • Follow procedures for reshaping berm materials and clearing vegetation. (See <i>Soil erosion and surface runoff</i> and <i>Forest land and tropical forest</i> mitigation measures outlined above.) Ensure grader operators and road crews apply techniques for managing spoil materials and cleared vegetation that minimize impacts on scenic quality. • Try to restrict road machinery and crew operations to low season and low traffic volume periods. • Ensure dozer operators and casual labor at quarries and borrow pits are following procedures for extraction of murrum, storage of topsoil, phased closure, and reshaping and restoration when extraction has been completed. Where appropriate, reseed or revegetate to reduce soil erosion, prevent gulying and minimize visual impacts. • Ensure construction camp sites are not visible from the tourist roads or tracks.

16.3	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Ensure vehicle per kilometer Limits of Acceptable (LAU) are followed for each designated park zone. • Apply murrum selectively where available and feasible to reduce the visual effects of dust for especially important scenic vistas and viewsheds. • Apply mitigative measures to restrict off-road driving (See <i>Habitat change and species diversity</i> mitigation measures above for a detailed discussion of off-road driving and mitigation strategies). • Ensure road crews follow procedures for handling and disposing of waste materials, and understand the rationale for maintaining roadsides in waste free condition. • Remove all abandoned materials and non-functional equipment from roadsides (preferably to a location outside the parks). • Enforce litter control— what goes in must come out. • Remove all wastes and process from a central location (preferably outside the parks). • Perform road maintenance when the number of visitors is low to minimize effects on scenic quality.
16.4	<i>Decommissioning</i>	<ul style="list-style-type: none"> • Close off abandoned roads and multiple tracks with barriers (e.g., rocks) and “CLOSED” signs to allow natural regeneration of vegetation to take place. • Rip and reshape abandoned road segments, where appropriate, such as those with high compaction or deep rutting, to encourage rapid revegetation and restoration to natural conditions (See <i>Soil erosion and surface runoff</i> above). Decommissioning activities may have a minor adverse impact on scenic quality of the park for a short period of time, but over the longer term they should have beneficial impacts. • Rehabilitate existing quarries and murrum pits that have an impact on the scenic quality of the park and, where possible, discontinue use of murrum from these sites.

17	Wilderness quality	
17.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • Ensure that TANAPA Wilderness policies, GMT and MZP wilderness zone plans are complied with prohibiting <i>motorized equipment or any type of mechanized transport in areas designated or zoned as wilderness with the exception of emergency situations involving human health or safety.</i> • Unless no other alternative is available, roads should pass around and not through wilderness zones. • Use the TANAPA policy (1994:30) "<i>minimum tool</i>" principle to provide emergency access to wilderness areas, for example, use of trails versus roads, small light motorized rescue and supply vehicles instead of transportation, or air transport. • Ensure that Park Wardens in Charge make staff, visitors, tour companies and developers fully aware of the importance of restricting wilderness access to the absolute minimum.
17.2	<i>Construction and operation</i>	<ul style="list-style-type: none"> • Ensure the use of TANAPA policy that requires use of the "<i>minimum tool</i>" principle regarding access to "wilderness areas."
17.3	<i>Decommissioning</i>	<ul style="list-style-type: none"> • Convert abandoned roads to natural state or to trails. See mitigation strategies for decommissioning in <i>Soil erosion and surface runoff</i> above.
18	Limits of acceptable use (LAU)/ carrying capacity	
18.1	<i>Planning and design</i>	<ul style="list-style-type: none"> • Strictly follow MZPs, where they exist. In light of the approximate doubling in the number of visitors to the parks over the past decade and anticipated road improvements, review existing management plans. Where in need of updating, or non-existent, take action to ensure their preparation or updating. • Conduct multidisciplinary surveys (ecologist, road engineer, geotechnical engineer, hydrologist, tourism specialist) for all new road segments or road

		<p>realignments and apply cost-benefit analysis to select routes which maximize benefits, while minimizing adverse environmental impacts.</p> <ul style="list-style-type: none"> • Where LAU's are approaching unacceptable levels from the addition of new roads or the upgrading of existing roads, consider upward adjustment of fees to balance visitor usage against zone LAUs or use booking systems to ensure planned LAUs are not exceeded. • Consider raising fees during the high season, and imposing more moderate fees during the wet season, so as to encourage more park use during the low visitor seasons. Also consider a promotional campaign to attract visitors during low season, perhaps by publicizing low season fees and wet season park attractions.
	Socio-economic considerations	
19	Human settlement	
19.1	<i>Construction and operation</i>	<ul style="list-style-type: none"> • Mitigate against vehicle and equipment dust and noise from traffic passing through communities outside the parks. See mitigation measures in <i>Risks and hazards</i> below. • Ask tour operators who stop at communities which border the national parks to incorporate cultural awareness and sensitivity into educational programs for their clientele. • See <i>Health and disease</i> below for additional mitigation recommendations.
19.2	<i>Indirect and induced effects</i>	<ul style="list-style-type: none"> • Work with District councils to develop regional environmental assessment capability and regional natural resource and environmental management plans. • Establish standards for development of roads leading to the national parks to control rapid and potentially adverse effects on the parks. • Work with communities and district councils to encourage enforceable plans for controlling the aesthetics of development along roads outside the parks. • Support CCSs need for sufficient resources, including vehicles, to help communities recognize the value of the parks, and to ensure that a significant portion of park benefits reach communities most affected by crop damage or injury caused by wildlife, and/or loss of income.

		<ul style="list-style-type: none"> • Utilize resources of park roads departments to assist neighboring communities in improving their farm to market roads, where appropriate, and to improve CCS access by road. • Support efforts to control in-migration of population to communities adjacent to national parks. • Support non-farm employment and family planning initiatives.
20	Costs and benefits to TANAPA and to local employment/ local economies	
20.1	<i>Construction</i>	<ul style="list-style-type: none"> • Encourage use of casual labor from adjacent local communities for road improvements, especially in small parks. • Conduct cost/benefit analyses of using potential murram sites outside the parks.
20.2	<i>Operation and Maintenance</i>	<ul style="list-style-type: none"> • Enforce the <i>Limits of Acceptable Use</i> for park zones. • Conduct annual park reviews of compliance with Limits of Acceptable of Use and the need for additional action, if any.
21	Health and disease	
21.1	<i>Construction and operation</i>	<ul style="list-style-type: none"> • Provide potable water, appropriate sanitary and solid waste disposal facilities for road crews. • Collect all solid waste (metal, glass, and burnables) from road crew sites, quarry sites and visitor rest points. • Require all tour operators and visitors to bag and remove all solid waste from the parks. Where feasible, employ a "check-in, check-out system" for all food consumed by visitors on road and trail circuits. • Remove solid waste to a central disposal location, preferably outside the parks. Where this is not feasible, incinerate burnable solid waste at a central location on site or in the park, and place food wastes in well-screened waste pits. Cover pits with soil weekly to control disease transmission from insects, birds and mammals.

		<ul style="list-style-type: none"> • Construct ventilated improved pit latrines (VIP) at permanent road crew camps, workshops and quarry sites, where feasible. • Instruct road crews to employ soil mining (digging a pit for human waste and covering with soil immediately after use) where pit latrines are not feasible. • Provide appropriate training in hygiene to road crews, including awareness and instruction in STD and AIDS prevention. • Provide visitors with designated sites for human waste disposal to avoid indiscriminate contamination of exceptional features (e.g., wetland areas, scenic overlooks, etc). • Through the Community Conservation Services (CCS), consult community representatives on the nature of quarry and murram pit restoration, as they may want them retained as water collection ponds. Discuss the potential for disease transmission with communities, particularly the risks associated with watering cattle, clothes washing, bathing, and taking drinking water from the same pond, and the increased threat toward the end of dry seasons as ponds evaporate. • Where populations (including pastoralists) outside the parks consider drainage ditches, pits, and quarries valuable water supply sources, educate users to use separate sources to water cattle, wash and obtain potable water. • Construct concrete pads with catch drains for vehicle and equipment repair and servicing. • Install oil/water separators in drains, as needed. • Repair leaking diesel pumps [repairs may pay for themselves quickly in fuel savings] and construct concrete pads to catch spilled fuel. • Collect all waste oil and remove it from the park, except for that portion used to treat timber. • Do not use waste oil to cut latrine odors. • Do not use waste oil as cooking fuel. • Identify buyers for the waste oil outside the national parks. • Minimize exposure of staff to petrol or diesel fumes by constructing or purchasing a long dipstick that can be inserted into the tank to check fuel levels without requiring personnel to enter the confined space of the tank. • Consider other methods for testing tank levels, including installation of piezometers on tank exteriors to allow direct fuel depth readings.
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		<ul style="list-style-type: none"> • Have mechanics wear gloves to minimize contamination of hands with hydrocarbon products (fuel, lubricants, etc.).
22	Air quality	
22.1	<i>Construction</i>	<ul style="list-style-type: none"> • Apply water on dust-generating surfaces and protect workers with equipment and clothing, as appropriate. • Use good quality murram, where feasible, to minimize dust and costs of constant re-surfacing. • Control dust through use of tarpaulins on murram tipper trucks.
22.2	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Selective application of (good quality) murram and compaction with water can significantly minimize dust. Where feasible, the use of one-way circuits can also reduce adverse dust effects.
23	Risks and hazards	
23.1	<i>Construction</i>	<ul style="list-style-type: none"> • Provide workers with ear plugs or head gear to mute noise from high decibel equipment. • Provide masks to workers exposed to large amounts of dust. • Avoid the creation of unprotected bodies of standing water outside the parks, or fence standing water bodies.
23.2	<i>Operation and maintenance</i>	<ul style="list-style-type: none"> • Evaluate worker safety issues in each park associated with road construction and maintenance. Provide safety equipment and institutionalize safety procedures and training, where appropriate. • Design roads to minimize speeding and enforce speed limits. See the mitigation suggestions in <i>Wildlife migration/movement and animal harassment</i> above. • Ensure mining of murram and fill is done in a manner which does not put workers or others at risk from falling rock or debris, collapsing quarry walls, or accidental falls from cliffs. • Enforce park regulations against feeding animals.

		<ul style="list-style-type: none"> • Store fuels and lubricants carefully and at safe distance from park facilities.
24	Tourist industry	
24.1	<i>Planning and operation</i>	<ul style="list-style-type: none"> • Ensure implementation and enforcement of General Management and Management Zone Plans for road improvements through annual reviews of the status of road improvements against GMP/MZPs. • Consider as part of annual review of the <i>Environmental Management Workplan</i> for each park, new road/trail improvements based on additional information on visitor trends and findings not captured in the GMP/MZPs. (See needed road assessment surveys recommended in the PEA under <i>Section 6.3.4 Sensitive areas and threatened and endangered species and ecological functioning</i>, <i>Section 6.3.5 Exceptional resources: ecological, paleontological, archaeological, historical and cultural</i>, and <i>Section 6.4.1 Scenic quality and viewshed</i>.) • Carefully assess annually the recommendations for new road improvements against the capacity (personnel, equipment and materials) of park works departments to maintain the existing road networks and the capacity of park personnel to meet enforcement and management requirements associated with proposed new roads or other road improvements. Make upward adjustments in personnel, equipment and materials to meet approved park recommendations for road improvements.

Section 4

Instructions for completion of environmental mitigation/enhancement and monitoring forms for road improvements

**Table 4. TANAPA Environmental Mitigation/Enhancement Form for Road Improvements
for Serengeti National Park [SAMPLE ONLY]
(To be submitted with annual *Environmental Management Workplan*)**

Adverse Impact Description: Soil Erosion

Impact No. 1

Year: 2001

Road Segment (junction to junction or road name): _____

No.	a. Description of Mitigation/Enhancement Measure	b. Description of Needed Followup	c. Followup Dates	d. Unit(s)/ Individuals Responsible (Initials)		e. Cost high(h); medium (m); low(l); very low (vl)	f. Mitigation Achieved (If yes, provide date. If no, elaborate below))
1.1	Planning and Design			Unit	Indiv		
1.11	Develop and provide TANAPA design stands to control erosion	Quarterly Review of Progress		TANAPA Headquarters Engineering and Planning Manager		L-M	
1.12	Develop standards for following contours, avoiding gradients greater than 10%, or long downhill straight stretches	Quarterly Review of Progress		TANAPA Headquarters Engineering and Planning Manager		L-M	
1.13	Use a multidisciplinary team in selecting new routes	On-going		ER Coordinator And TANAPA Planning Manager			
1.2	Construction						
1.2.1	Minimize amount of clearing			Works		L	
1.2.2	Limit earth moving to dry seasons			Works		L	
1.2.3	Protect disturbed areas			Works		M	
1.2.4	Store topsoil for respreading			Works		L	
1.2.5	Installation of temporary erosion protection	Check to see protection is still in place		Works		M	

No.	a. Description of Mitigation/Enhancement Measure	b. Description of Needed Followup	c. Followup Dates	d. Unit(s)/ Individuals Responsible (Initials)	e. Cost high(h); medium (m); low(l); very low (vl)	f. Mitigation Achieved (If yes, provide date. If no, elaborate below))
1.2.6	Installation of permanent erosion protection	Check to see protection is still in place		Works	H	
1.2.7	Revegetation of disturbed areas	Check to see reveg doing OK		Works	M	
1.2.8	More drainage turnouts as required based on erosion	Clean as required		Works	M	
1.2.9	Drainage check dams as required based on erosion	Repair as required		Works	M	
1.2.10	Higher quality murrum or surfacing based on continuing road damage			Works	H	
1.2.11	Sufficient culverts for good distribution of surface runoff			Works	M	
1.2.12	Minimize cuts/fills in sensitive areas (wetlands)			Works	H	
1.2.13	Install oil/water separators for maintenance yard surface runoff			Works	H	
1.3	Operation					
1.3.1	Maintain drainage structures	Clean as required		Works	M	
1.3.2	Maintain roadway surface	Grade as required		Works	M	
1.3.3	Close roads that may be damaged during wet season			WIC	H	
1.3.4	Use higher grade murrum on heavily-used route			Works	H	
1.3.5	Temporarily close road to allow environment to recuperate			WIC	H	
1.3.6	Install/maintain water-catchment trenches	Clean as required		Works	M	
1.3.7	Fill potholes, remove downed trees/limbs	As required		Works	M	
1.3.8	Control fuel/oil/wastes to prevent water contamination	Inspect Yearly		Works	H	
1.3.9	Ensure drainage turnouts sufficient to allow runoff percolation	Inspect Yearly		Works	M	
1.3.10	Minimize surface water use for roads during dry season			Works	M	

1.3.11	Prewet murrum prior to dry season; store to keep damp			Works	M	
1.3.12	Monitor fuel tanks and fuel piping for leakage	Monthly		Works	M	
1.3.13	Collect/remove all waste oil	Monthly		Works	M	
1.3.14	Install concrete fueling pads			Works	H	
1.4	Decommissioning (Restoration)					
1.4.1	Reroute / decommission original road segment			WIC	H	
1.4.2	Ensure successful vegetation	Verify reveg survival		Ecologist	M	
1.4.3	Provide drainage/shaping as required to prevent erosion/siltation	Verify erosion not occurring		Works	M	

Problem(s) Encountered:

Nature of needed followup action:

Responsible individual for followup:

Schedule for followup:

Other comments:

Signature of Preparer: _____ **Date:** _____

Completing the monitoring forms

1. Briefly describe the adverse environmental impact under consideration, matching the completed mitigation forms for the annual *Environmental Management Plan Guidelines* for road improvements.
2. Enter the adverse environmental impact number found in *Section 3* of these *Guidelines* for the environmental impact under consideration.
3. Enter the year covered under this annual *Environmental Management Workplan* submission.
4. Identify the road segment (junction to junction or road name).
5. In column a, describe the appropriate mitigation/enhancement measures/issues/elements to be monitored by activity phase (planning & design, construction, operation & maintenance, and decommissioning (abandonment)).
6. Assign each monitoring measure a number for tracking purposes (e.g., 1, 2., 3, etc.)
7. Under column b, identify who will be responsible for carrying out each of the identified monitoring measures. (Try to be as specific as possible. It is better to identify a specific individual with responsibility rather than simply to name an entire department or unit.)
8. Under column c, describe the indicator(s) used for monitoring.
9. Under column d, describe the monitoring method to be used.
10. Under column e, identify the monitoring frequency needed.
11. In column f, estimate the cost for each monitoring measure. Try to be specific, but if this is not possible, indicate whether the cost will be high, medium, low or very low.
12. Leave columns f and g blank. Fill in when monitoring has taken place or problems have been encountered, or describe implementation problems during mid- and end-of-year reviews.
13. Note nature of monitoring problems encountered, nature of needed followup action, responsible individual for followup, and the schedule for followup.
14. Provide additional comments, if needed.
15. Sign and date the form.
16. Submit forms as Part 5 of the annual *Environmental Management Workplan* for road improvements.

**Table 5. TANAPA Road Improvements Environmental Monitoring Form
for Serengeti National Park [SAMPLE ONLY]
(To be submitted with annual *Environmental Management Workplan*)**

Adverse Impact Description: Soil Erosion

Impact Number: 1

Year: 2001

Road Segment (junction to junction or road name): _____

No.	a. Mitigation/Enhancement Measure/ Issues/Elements to be Monitored	b. Unit(s)/ Individuals Responsible		c. Indicator(s) For Monitoring	d. Monitoring Method Used	e. Monitoring Frequency	f. Monitoring Cost high(h); medium (m); low(l); very low (vl)	g. Problem Encountered Check if yes, and elaborate below)	h. Monitor Date(s):
		Unit	Indiv						
	Design								
	Construction								
1	Minimize amount of clearing	Works		Erosion	Visual inspection	daily	L		
2	Limit earth moving to dry seasons	Works		Erosion	Visual inspection	daily	L		
3	Restore disturbed areas	Works		Erosion	Visual inspection	Start, midterm, finish	M		
4	Store topsoil for resspreading	Works		Erosion	Visual inspection	Start, midterm, finish	L		
5	Installation of temporary erosion protection	Works		Erosion	Visual inspection	Start, midterm, finish	H		
6	Installation of permanent erosion protection	Works		Erosion	Visual inspection	Start, midterm, finish	H		
7	Revegetation of disturbed areas	Ecologist		Reveg and erosion	Visual inspection	Start, midterm,	M		

No.	a. Mitigation/Enhancement Measure/ Issues/Elements to be Monitored	b. Unit(s)/ Individuals Responsible	c. Indicator(s) For Monitoring	d. Monitoring Method Used	e. Monitoring Frequency	f. Monitoring Cost high(h); medium (m); low(l); very low (vl)	g. Problem Encountered Check if yes, and elaborate below)	h. Monitor Date(s):
					finish			
8	Reroute / decommission original road segment	Ecologist	Reveg and erosion	Visual inspection	Start, finish, +1 year	L		
9	More drainage turnouts as required based on erosion	Works	Erosion	Visual inspection	Start, finish, +1 year	M		
10	Drainage check dams as required based on erosion	Works	Erosion	Visual inspection	Start, finish, +1 year	M		
11	Higher quality murrum or surfacing based on continuing road damage	Works	Road surface deterioration	Visual inspection Visual inspection	Start, finish, +1 year	M		
12	Sufficient culverts for good distribution of surface runoff	Ecologist	Vegetative effects each side of road	Visual inspection photos	Start, finish, +1 year	M		
13	Minimize cuts/fills in sensitive areas (wetlands)	Ecologist	Vegetative effects each side of road	Visual inspection	Start, finish, +1 year	M		
14	Install oil/water separators for maintenance yard surface runoff	Works	Oil in separator	sample	monthly	M		
	Operation							
15	Maintain drainage structures	Works	Erosion & siltation	Photos	yearly	M		
16	Maintain roadway surface	Works	Surface condition	Photos	yearly	M		
17	Close roads that may be damaged during wet season	Works	Surface damage	Inspect	Start of wet season	H		
18	Higher grade murrum on heavily-used route	Works	Surface condition	Photos	yearly	M		

19	Temporary road closure to allow environment to recuperate	Works	Surface condition	Photos	yearly	H		
20	Install/maintain water-catchment trenches	Works	Erosion & siltation	Photos	yearly	M		
21	Fill potholes, remove downed trees/limbs	Works	Multiple tracks	Inspect	3 months	M		
22	Fuel/oil/wastes controlled to prevent water contamination	Works	Oil on ground	Inspect	3 months	M		
23	Drainage turnouts sufficient to allow runoff percolation	Works	Erosion & siltation	Photos	yearly	M		
24	Minimize surface water use for roads during dry season	Works	Lack of surface water	Inspect	Midway through dry season	L		
25	Prewet murram prior to dry season; store to keep damp	Works	Moisture evident	Inspect	Midway through dry season	L		
26	Monitor fuel tanks and fuel piping for leakage	Works	Oil on ground	Inspect	3 months	M		
27	Collect/remove all waste oil	Works	Oil on ground	Inspect	3 months	M		
28	Install concrete fueling pads	Works	Oil on ground	Inspect	3 months	M		
	Decommissioning (Restoration)							
29	Ensure successful revegetation	Ecologist	Reveg and erosion	Photos	Start, finish, +1 year	M		
30	Provide drainage/shaping as required to prevent erosion/siltation	Works	Reveg and erosion	Photos	Start, finish, +1 year	M		

Problem(s) Encountered:

Nature of needed followup action:

Responsible individual for followup:

Schedule for followup:

Other comments:

Signature of Preparer: _____ **Date:** _____

Section 5

Template: environmental mitigation/enhancement and monitoring forms for road improvements

TANAPA Road Improvements Environmental Management Plan - Mitigation Status
(To be submitted with annual *Environmental Management Workplan*)

Adverse Impact Description: _____ Impact No. _____ Year _____

Road Segment (junction to junction or road name): _____

No.	a. Description of Mitigation/Enhancement Measure	b. Description of Needed Followup	c. Followup Dates	d. Unit(s)/ Individual(s) Responsible (Initials)		e. Cost high(h); medium (m); low(l); very low (vl)	f. Mitigation Achieved (If yes, provide date, if no, elaborate below)
				Unit	Indiv		
	Design						
	Construction						

No.	a. Description of Mitigation/Enhancement Measure	b. Description of Needed Followup	c. Followup Dates	d. Unit(s)/ Individual(s) Responsible (Initials)		e. Cost high(h); medium (m); low(l); very low (vl)	f. Mitigation Achieved (If yes, provide date, If no, elaborate below)

Problem(s) Encountered:

Nature of needed followup action:

Responsible individual for followup:

Schedule for followup:

Other comments:

Name of Preparer (Print): _____

Title of Preparer: _____

Signature of Preparer: _____

Date: _____

TANAPA Road Improvements Environmental Management Plan - Monitoring Sheet
(To be submitted with annual *Environmental Management Workplan*)

Adverse Impact Description: _____ Impact No. _____ Year _____

Road Segment (junction to junction or road name): _____

No.	a. Description of Mitigation/ Enhancement Measure/Issues/ Elements to be Monitored	b. Unit(s)/ individual(s) Responsible (Initials)		c. Indicator(s) Used for Monitoring	d. Monitoring Method Used	e. Monitoring Frequency Needed	f. Monitoring Cost High(h) Medium (m) Low(l) Very low (vl)	g. Problem Encountered (Check if yes, and elaborate below)	h. Dates Monitored
		Unit	Indiv						
	Design								
	Construction								

No.	a. Description of Mitigation/ Enhancement Measure/Issues/ Elements to be Monitored	b. Unit(s)/ Individual(s) Responsible (Initials)		c. Indicator(s) Used for Monitoring	d. Monitoring Method Used	e. Monitoring Frequency Needed	f. Monitoring Cost High(h) Medium (m) Low(l) Very low (vl)	g. Problem Encountered (Check if yes, and elaborate below)	h. Dates Monitored
	Operation								

No.	a. Description of Mitigation/ Enhancement Measure/Issues/ Elements to be Monitored	b. Unit(s)/ Individual(s) Responsible (Initials)		c. Indicator(s) Used for Monitoring	d. Monitoring Method Used	e. Monitoring Frequency Needed	f. Monitoring Cost High(h) Medium (m) Low(l) Very low (vl)	g. Problem Encountered (Check if yes, and elaborate below)	h. Dates Monitored
	Decommissioning (Restoration)								

Problem(s) Encountered:

Nature of needed followup action:

Responsible individual for followup:

Schedule for followup:

Other comments:

Name of Preparer (Print): _____

Title of Preparer: _____

Signature of Preparer: _____

Date: _____

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